Dräger

Auto Flow®
20 Questions – 20 Answers

Joseph Fitzgerald

Important Notice:

Medical knowledge changes constantly as a result of new research and clinical experience. The author of this introductory guide has made every effort to ensure that the information given is completely up to date, particularly as regards applications and mode of operation. However, responsibility for all clinical measures must remain with the reader.

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Explanatory note: In some regions of the world IPPV mode of ventilation is referred to as CMV and Assist/CMV. The mode BIPAP is referred to as PCV+ in the USA and Canada. BIPAP* is trademark used under licence. AutoFlow® is registered as a trademark of Dräger Medizintechnik GmbH.

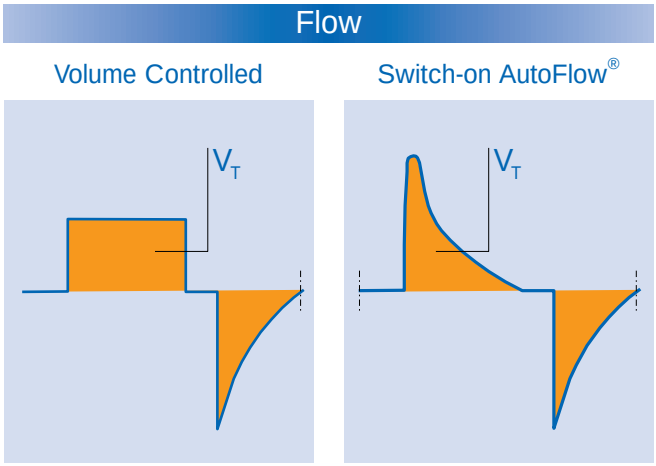
1. What is AutoFlow®?

This is a new advance in volume controlled modes of mechanical ventilation where the ventilator automatically regulates inspiratory flow. This auto regulation is in accordance with the set V_T and current lung compliance.

The set V_T is always given at minimum possible pressure and spontaneous breathing is possible (open valves) through the whole Inspiratory and Expiratory phases of the mechanical ventilatory cycle.

A decelerating flow pattern reduces Peak pressures and as lung compliance changes further they are recognised and responded to.

A decelerating flow pattern reduces Peak pressures



2. Is AutoFlow® a new Ventilator Mode?

It is a new addition to all volume controlled modes on the Evita 4 and Evita 2 dura ventilator. It is not a mode independently selected in itself. It could be compared to the way one function enhances another such as flow trigger enhances pressure support.

It is intended to simplify strategies in mechanical volume controlled ventilation by offering more patient benefits with a wider therapy range and with less parameters to adjust.

3. When would you use AutoFlow®?

There are very few exceptions to using AutoFlow® in all volume oriented modes where it is available. In general we can divide its use into two areas, that of the type of ventilatory strategy we want to apply and that of the type of patient that it is particularly suited to. In the first case in volume strategy ventilation where we want to reduce high airway pressures and capitalise on spontaneous breathing with reduced use of sedation and muscle relaxants. The decelerating flow and the regulated inspiratory and expiratory valves provide a response to every inhalatory and exhalatory effort of the patient. This feels like breathing through an open system.

In other strategies we may want to use inverse ratio timings. The occlusion of the expiratory valve for such lengths of time can produce risk of barotrauma for a patient who becomes awake and starts breathing. With an open breathing system this risk is greatly reduced.

In terms of patient types, there are those with quite variable compliance levels after surgery who require careful manipulation of inspiratory pressure and volume to prevent barotrauma and hyperinflation. AutoFlow® continually adjusts the pressures as compliance changes to ensure volume delivery at the lowest possible pressures.

Finally, as a smooth weaning strategy we want the first efforts by the patient to be responded to in all phases of the mandatory stroke unlike conventional modes of SIMV where there are closed phases in the cycle. The fixed set V_T delivery of SIMV is also addressed for Bronchospasm patients with air hunger as all demands for flow and volume are responded to by the ventilator.

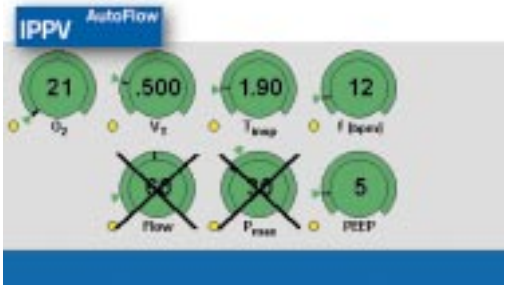
4. How does AutoFlow® compare to BIPAP?

BIPAP has been established for a number of years as a real advance in pressure controlled ventilation strategies. Pressures are regulated at a specific value and pressure peaks are eliminated and together with time synchronisation the patient is able to breathe spontaneously at any stage. Many of these features are now transferred across into the volume controlled modes as the benefits of this therapy have become more extensively accepted. The prime parameter setting in BIPAP is inspiratory pressure (Pinsp) and tidal volume (V_T) is variable, the prime adjustment in AutoFlow® is V_T and the pressure is the variable, depending on the compliance.

Many benefits of BIPAP are transferred into volume controlled modes with AutoFlow®

5. How is AutoFlow® combined with other modes such as IPPV?

The addition of AutoFlow® to IPPV mode for example is achieved by the on-going measurement of pressure, flow, volume and lung compliance and a ventilator response that regulates the flow to achieve the set V_T in the inspiratory time available. When you switch on there is a change from manual control to an automatic control of the inspiratory flow. Other than the removal of the control knobs of pressure (P_{max}) and flow from the touch screen panel all the core settings including trigger function and pressure support capability are totally unaffected.



The core settings including trigger function and pressure support are unaffected.

6. How does AutoFlow® work with SIMV?

AutoFlow® supports the preservation of an intact respiratory drive as less sedation and muscle relaxants are used.

Equally in SIMV any of the usual parameters such as PEEP are fully functional and superimposing AutoFlow brings auto-regulation to the flow and pressure.

The associated potential advantages have a domino effect in that a lower peak pressure usually means a lower mean airway pressure with a positive effect on haemodynamics, the inspiratory flow varies according to individual patient needs and may alter on a breath to breath basis. AutoFlow® supports the preservation of an intact respiratory drive as less sedation and muscle relaxants are used. The matching of flow and volume to patient needs in synchrony with inspiratory time at minimum pressure promotes harmony between patient and ventilator. This reduces considerably the phenomena known as “fighting the ventilator” which is a misnomer in that the “ventilator fights the patient” with its imposed fixed settings.

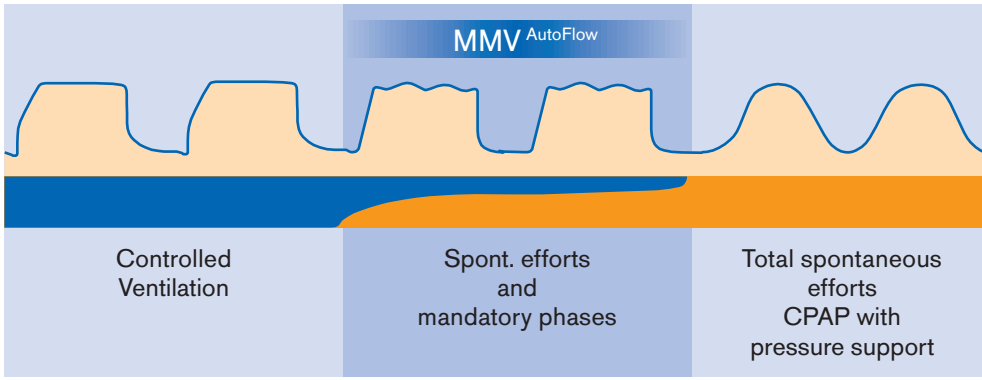
7. How does AutoFlow® work with MMV?

The mode is similar to SIMV in many respects where the clinician sets a rate and V_T for the patient to satisfy adequate gaseous exchange. It differs from SIMV in that as spontaneous breathing activity increases and the patient achieves more than the set mandatory minute volume then the mechanical strokes fade into the background. The patient, often with the aid of pressure support takes over the full volume work of minute ventilation. In MMV, AutoFlow influences the mechanical strokes if present and reduces asynchrony by allowing spontaneous breathing activity and reducing pressures to a minimum.

No ventilator adjustment required when going from fully controlled ventilation to full spontaneous breathing.

The logical progression of this is that the patient can be sedated and on full controlled ventilation, as he wakes up he will still get mechanical strokes but he will be able to breathe through them and not experience any discomfort with these breaths ,as his contribution increases the ventilator breaths fade away completely so the patient does not have to be switched to a weaning mode.

In addition to this if we now use the Ideal Body Weight setting and programme the weight into the ventilator before start of therapy then the right volume and ventilator settings will be selected for that patient and appropriate alarm defaults also. All this means that post operatively we can easily select what we want for the patient and in straight forward ventilation cases we can start with full ventilation therapy and go right through to full spontaneous breathing without having to readjust the ventilator.

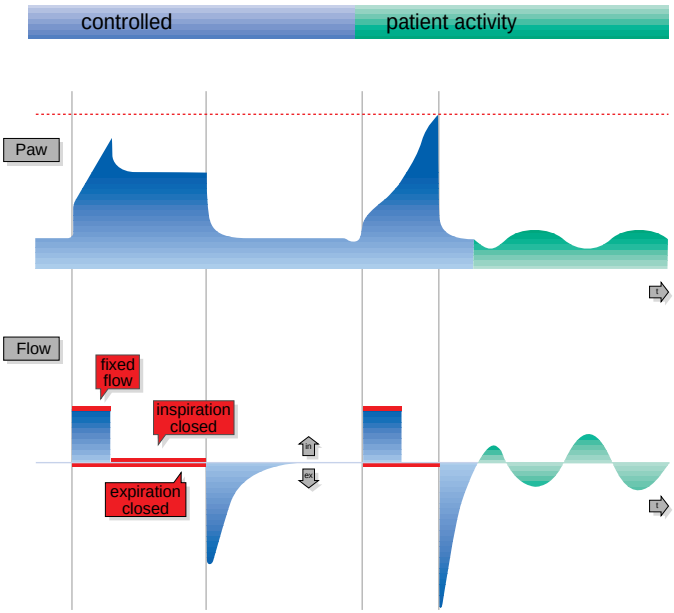

MMV AutoFlow
Controlled Ventilation
Spont. efforts and mandatory phases
Total spontaneous efforts CPAP with pressure support

Ideal body weight 70 kg

- Select Ideal Body Weight (70 kg).
  Key values and alarms set automatically
- Set ventilator to standby function.
- Connect arriving patient. Start ventilation
- Record monitored parameters
- Maintain observation of the patient as they wake up.

8. How does ventilation with AutoFlow® compare with volume controlled ventilation?

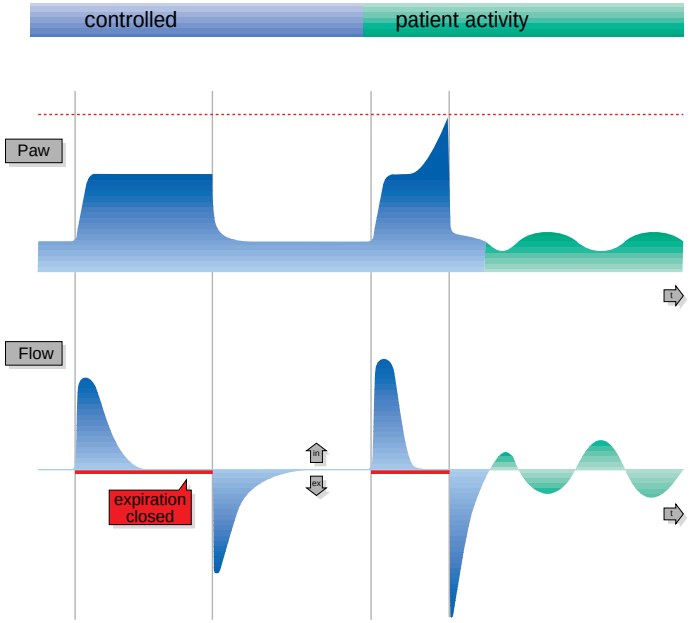
The constant flow in Volume controlled modes does not always match inspiration times, flow and volume do not always match patient demand leading to asynchrony. Peak pressures are often high sedation and paralysis are used to adapt patient to the ventilator. Spontaneous breathing if allowed is a futile struggle against closed valves. Attempts to exhale during mandatory phase activate high airway pressure alarms. The freedom for the patient to cough freely and clear his own secretions during volume controlled modes is usually suppressed. In any situation AutoFlow® always provides safety and lower pressures compared to normal volume controlled modes.



9. How does ventilation with AutoFlow® compare to pressure regulated modes?

AutoFlow® decelerates flow automatically similar to pressure controlled ventilation. Inspiratory pressure follows compliance similar to plateau pressure in volume controlled ventilation.

It differs from conventional pressure limited modes and Pressure Regulated Volume modes in allowing spontaneous breathing at any phase. It guarantees a set V_T and keeps pressure to a minimum whereas pressure controlled modes keep pressure constant and allow the V_T to vary. AutoFlow® brings many of the features of PCV to volume oriented modes and allows the benefits experienced by BIPAP users for example to be shared with those who wish to pursue volume only strategies.



10. What type of lung diseases is AutoFlow® suitable for?

The use of AutoFlow® is indicated as part of a volume oriented strategy in all cases where you can expect quick changes and short term improvement of lung compliance.

It is recommended in post surgical cases where acute restriction is evident and you want to guarantee normal ventilation. In acute lung oedema where high airway pressures are initially acceptable but as the treatment programme takes effect pressures will go down automatically and volumes will stay constant. Using AutoFlow® with a volume controlled mode is easier to handle than pressure control in this situation.

In cases where local atelectasis resulting from trauma or pneumonia requires frequent repositioning of the patient, in these situations Pressure Control would produce great volume changes and AutoFlow® in volume control modes will provide stable volumes at minimum pressures.

Finally, AutoFlow® is suitable for all start up ventilation therapy scenarios where there is limited information on disease status available and it is important to get therapy underway where pressures and flow are regulated and spontaneous activity is not compromised.

11. Are there situations where it is not indicated?

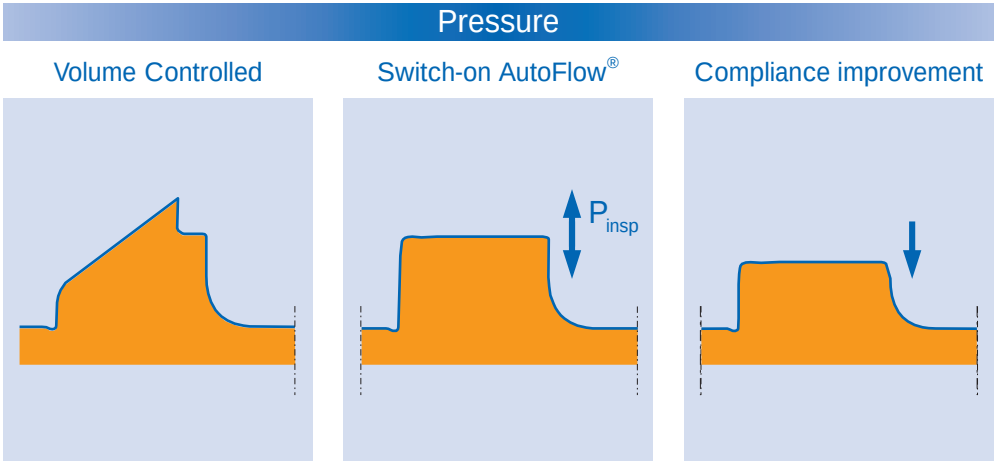
The range of uses of AutoFlow® is determined by the limitations of volume controlled modes and these modes are not always recommended for very severe diseases with long term healing processes with several days to weeks required to improve lung conditions. These cases where Acute Lung Injury and ARDS are clearly established often require a defined pressure control strategy such as BIPAP or APRV mode where the small volumes associated with the reopening lung are essential for blood gas improvement. Current opinion among the experts advocate reducing the risk of barotrauma by regulation of pressure and minimal volume strategy.

Volume controlled ventilation may not be indicated where there is a risk of intrinsic PEEP and the associated danger of over inflating the lung in a volume controlled strategy, especially where there are obstructive disorders or long (inverse) ratios are required. In these cases BIPAP mode with respect to decelerating flow and spontaneous breathing activity has the same advantages as AutoFlow®.

Lung disease is the real indicator and pressure or volume strategy is selected accordingly.

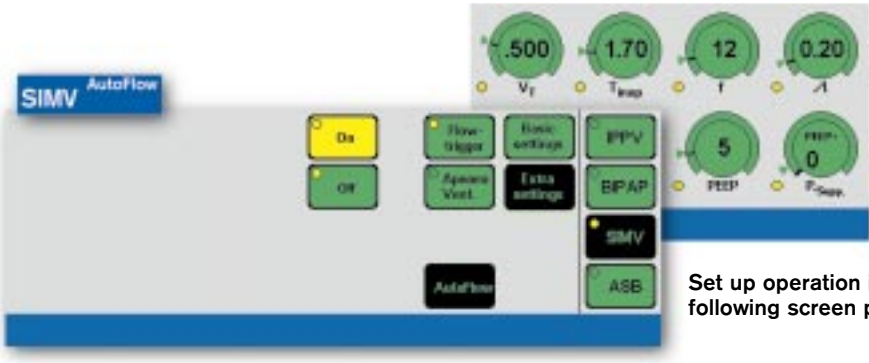
12. What has to be considered when switching from conventional modes to AutoFlow®?

The important point is that settings stay the same and if there is no patient activity there will be no variance in V_T. PEEP and Tinsp and mandatory frequency remain stable. Setting the flow control is not necessary as there is automatic regulation. As in all volume control modes setting the upper Paw alarm is important for the upper pressure threshold. Ventilation related sedation can be reduced to avail of the full benefits of spontaneous breathing.



13. How do you set up AutoFlow®?

AutoFlow® is switched on through “extra settings” on touch screen and rotary confirm knob. Conventional parameters – Freq, Tinsp, V_T and PEEP are set as desired. Upper Paw alarm should be set to warn of sudden compliance decrease or resistance increase and subsequent pressure changes. Upper Insp V_T alarm can be set to indicate increasing spontaneous breathing V_T demands.



Set up operation is by following screen prompts.

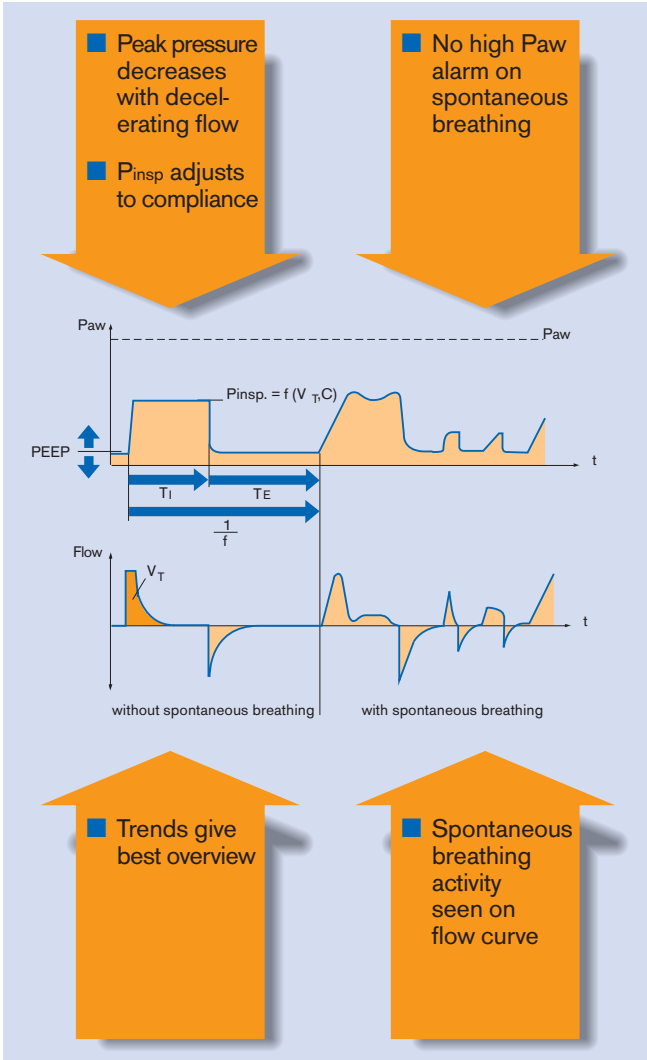
14. What monitoring parameters are important to observe when using AutoFlow®?

On switch on Peak pressure decreases as flow decelerates

In case the V_T is not applied a V_T low alarm is automatically generated.

Pinsp will adjust as compliance alters. Mean pressures will follow. The inspiratory flow pattern will alter (may lengthen) to accommodate resistance changes. Airway pressure high alarm unlike conventional ventilation will not occur (but should always be set). In case the V_T is not applied because of high resistance a V_T low alarm is automatically generated.

Spontaneous breathing activity will appear on flow curve. No high Paw alarm will activate on active expiration and mean V_T equals set V_T. Pressure, V_T and SB rates are monitored and displayed in any format which is preconfigured. Observance of the PV loops on the screen will show much improved pressure to volume relationships. Trends for many of these parameters provide a good indicator of clinical progress.


Peak pressure decreases with decel-erating flow
Pinsp adjusts to compliance
No high Paw alarm on spontaneous breathing
Paw
Paw
Pinsp. = f (V T,C)
PEEP
t
TI
TE
1/f
Flow
VT
t
without spontaneous breathing
with spontaneous breathing
Trends give best overview
Spontaneous breathing activity seen on flow curve

15. What are the advantages to observe when using AutoFlow®?

Peak and Mean airway pressures are reduced. Less invasive, less mechanical controlling by the ventilator. In the presence of leaks AutoFlow® recognises and compensates accordingly. Less requirement for sedation and muscle relaxants which have many other systemic effects. Spontaneous breathing contributes to better gas exchange and secretion clearance. Weaning is more smooth and can start earlier. Greater comfort and less stress for patients should in turn reduce stress levels for clinical staff.

Finally, the need for fewer control knobs to adjust and less alarms to manage are seen as real advantage in the busy intensive care unit.

16. What would be the subsequent management of the patient?

Each case is different but a general strategy during weaning would be to reduce FiO_2, maintain PEEP above lower inflection point, reduce Tinsp to I:E of 1:1 and reduce Frequency.

As patient activity increases and patient inhales with the mandatory stroke inspiratory pressures will automatically reduce and the next step is Pressure Support to assist the spontaneous breathing.

The significant point of management is the early move to spontaneous breathing because of the open system which allows an early parallel reduction in mechanical ventilation. The use of CPAP combined with Pressure Support to compensate for the work of breathing through the tube is usually indicated as the final therapy stage.

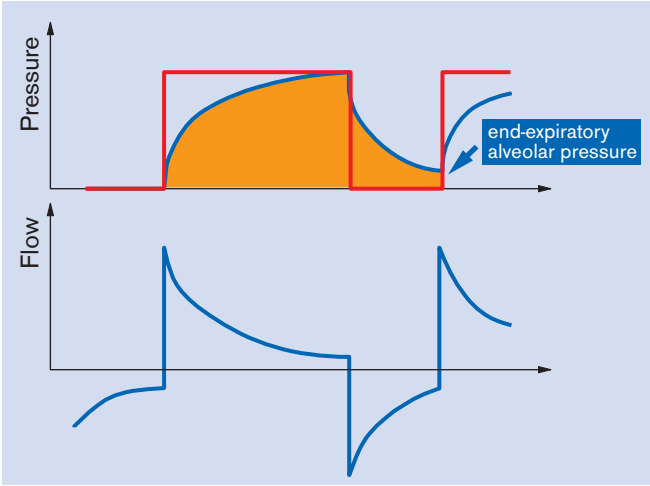
The tranisition to final weaning steps is simple and straightforward.

17. What are the safeguards against hypo/hyperventilation?

The safeguards against too much or too little volume come in three forms. Firstly the user is prevented from making unusual inadvertent settings by use of on screen advice and having to confirm before being able to implement these settings. Secondly the increasing incremental steps as compliance changes are just 3 mbar and are limited to 5 mbar below the set upper airway pressure alarm. Thirdly, the automatically activated Volume inconstant alarm warns if the set V_T is not applied due to compliance or resistance changes. The upper airway pressure alarm warns of extreme coughing or obstruction. The V_{Ti} alarm limits the inspiratory volume in the event of too great a volume demanded.

Frequent triggering by the patient does not lead to hyperventilation in the modes SIMV and MMV and where it might have been possible in CMV/Assist the trigger can be turned off but the patient is still allowed to breathe spontaneously.

18. How does AutoFlow® interact with inverse ratio ventilation?



AutoFlow® is ideally suited to extended inspiratory times.

AutoFlow® is an excellent adjunct to long inspiratory time settings. Clinical experience is limited but if we carry across the reported experiences of Sydow et al(2) and apply a ventilatory strategy where spontaneous breathing is encouraged with the longer inspiratory times but overall pressures are low then this should provide a good indication for its use in an IRV format. Not withstanding the impact of air trapping this should actively contribute to reducing the risk of barotrauma which is often associated with IRV.

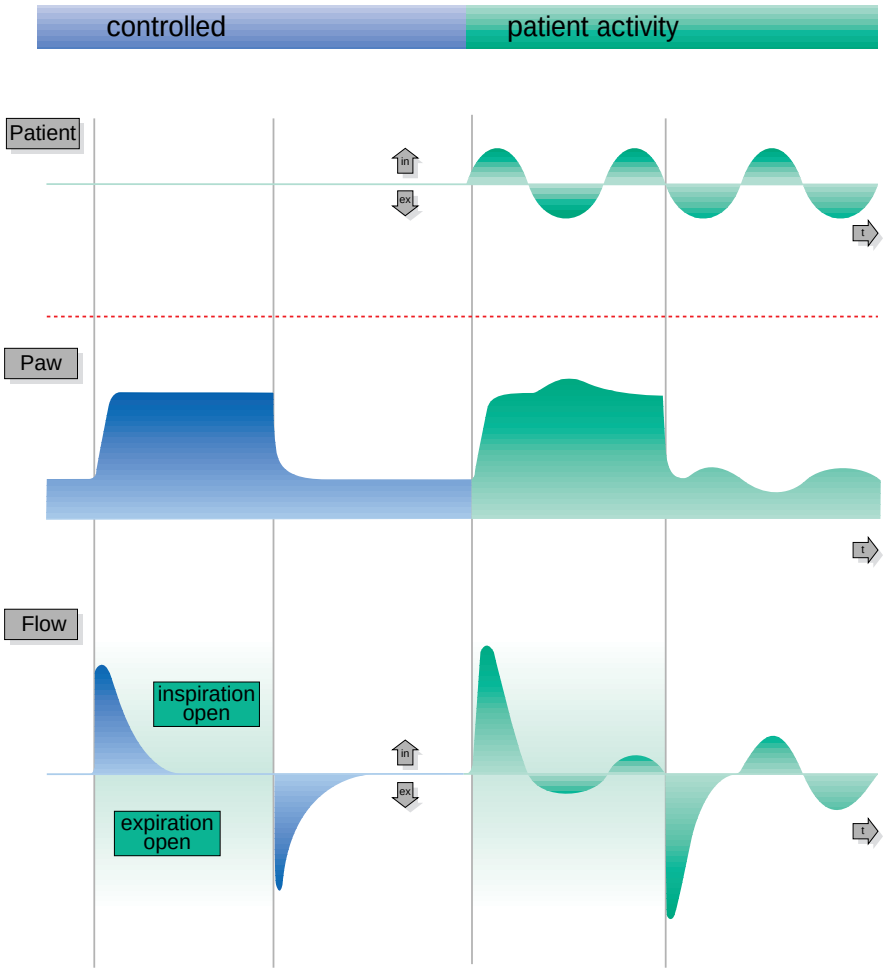
19. How can mechanical ventilation and spontaneous breathing be mixed in one mode?

To facilitate spontaneous inspiration and expiration in each phase of controlled mechanical ventilation is a technological challenge. This unique solution is based on an intelligent microprocessor system combined with highly sophisticated valves, flow and pressure sensors.

New microprocessor systems combined with sophisticated valves provide new solutions.

Conventional technology with the delivery of fixed flow and volume in each mandatory breath is contrary to free spontaneous breathing by the patient. Volume control with AutoFlow® is therefore provided on a breath to breath basis. In each individual breath the patient has the possibility to increase or reduce the delivered volume. The ventilator monitors the inspiratory volume and compensates for deviations in the next breath.

In case the volume was too low, volume of the next breath will be automatically adjusted by increased inspiratory pressure (Plateau). If the volume was too high either because of spontaneous inspiration or improving compliance, inspiratory pressure will automatically go down with the next breath. For smooth interaction with the patient the pressure changes are limited to maximum of 3 cm H_2O from breath to breath. Great pressure fluctuations because of unique events like a cough or a spontaneous sigh are thus avoided.



AutoFlow® responds like a CPAP system with CPAP value set to Pinsp. Whenever the patient tries to inhale more volume the demand valve will deliver more flow, whenever he wants to exhale the expiration valve will allow expiratory flow while the pressure/PEEP level is kept constant. The graphs above illustrate this.

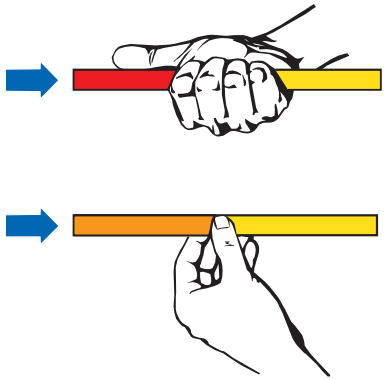
The patient can inhale and exhale as usual in SIMV/MMV and now even in the expiratory phase of IPPV.

20. What is the technology behind this latest advance in therapy?

All the electronic and pneumatic subsystems need to be optimised for a function like AutoFlow®.

The accurate control of flows and pressures is an essential basic requirement, but only intelligent algorithms and fast adjustments of the valves can provide the required responsiveness to patient activities.

Expiration valve closed or Expiration valve controlled



Evita ventilators have highly responsive inspiratory demand valves that can open and close in milliseconds on command of the microprocessor system, while keeping the FiO_2 and pressure constant. This minimises patient work of breathing and helps avoid inefficient breathing efforts.

The integrated special exhalation valve design with a large control orifice provides low resistance to exhalation. Pressure is controlled smoothly with fast responses throughout the whole setting range of PEEP and inspiratory pressures. As the picture here on the left illustrates, the exhalation valve is never occluded completely, the closing pressure is always equal to the corresponding PEEP or inspiratory pressure. Like a pop off valve it permits expiratory flow if the pressure exceeds the set value.

Last but not least accurate and robust pressure and flow sensing systems on both in- and expiratory side are a basis for all these functions.

Summary Statement of Benefits of Auto Flow®

Physiologic	facilitates the recognised importance of spontaneous breathing in controlled ventilation
Synchrony	flow and volume adapted to patient needs
Automatic	complete weaning therapy in many situations when MMV is combined with Ideal Body Weight and one pre-setting.
Simplification	ventilatory therapy with less control knobs and less alarms
Evidence	All proven benefits of BIPAP now transferred to volume controlled ventilation

Volume controlled ventilation takes a major step forward.

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